The Mexican Electricity Market: Regional Forecasting and Restructuring of the Power Industry

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Abstract

Mexico, like many other emerging countries, is interested in restructuring its electricity industry. Mexico is moving from almost complete control of production, transmission and distribution of the electricity market by the government, to a situation in which private participation in electricity generation is allowed. This paper describes the Mexican electricity market after several years of operation of this new production arrangement and states some efficiency measures (technical and nontechnical losses and other criteria) of the actual electricity system. To understand the evolution of the Mexican electricity market, we have taken a regional approach. There has been a significant shift in the geographical location of production since NAFTA implementation. In our regional approach prices, supply and demand are analyzed for use in anticipating the electricity market situation going forward. Finally, in accordance with our analysis, several proposals are drawn to advance the restructuring of the Mexican electricity market.

Introduction

Mexico's electricity market, as in the case of the petroleum industry, works almost entirely through a single producing company, the *Comisión Federal de Electricidad* (CFE). Transmission is operated mainly by the CFE, but distribution and marketing are handled by the CFE and by *Luz y Fuerza del Centro* (LFC), which operates in Mexico City. The operating scopes of each entity are defined by regions and, from the point of view of their organizations, each public enterprise is independent of the other. The dominant power of the CFE in electric power generation, transmission and distribution is well known despite the 1992 reform to the Law of Public Service of Electricity. This reform sought to increase the participation of the private sector (both domestic and foreign companies) in the generation of electricity for the national market. According to an official document[1] the outcome has not been very encouraging. In 1999, CFE's participation in the capacity of generation of electricity was 90 percent, Petroleos Mexicanos or Pemex (Mexico's national oil company) 4.4 percent, LFC 2.3 percent and private companies 3.3 percent.

The private sector can participate in cogeneration, self-use production, in BLT projects (build, lease and transfer) and as independent power producers (IPPs). The main characteristics of each one of these categories can be described as follows:

- In the case of cogeneration and self-use production, any surplus production has to be sold to the CFE at a price fixed by the regulator.
- In the BLT projects, building and financing are the responsibility of the private investor. The CFE only supervises the project. When construction is complete, the plant is operated by the CFE. After two years of operation, the developer is paid as a financial leasing of the asset. The project's costs are registered as direct private investment (regardless of whether it is domestic or foreign), and after two years it is converted to public debt (again, regardless of whether the IPP is domestic or foreign).
- In the case of IPPs, the CFE guarantees the price and the market (total or partial) to private investors. They receive a concession for 30 years to operate the plants, after which the assets become CFE's property.

BLT and IPP projects are subject to public bidding, but once they are granted the market risk disappears for the investors. Financial risk does not exist either, given that the financial liabilities of the CFE become public debt.[2] It is interesting that from the increase in generation capacity carried out or to be carried out from the year 1998 to the year 2001, CFE resources will fund only 2 percent. The remainder will be BLT and IPP projects. This data clearly shows the dependency of the CFE on the federal government, and for the same token, it is a good indicator of the incipient development of the electric power market.

Restructuring Mexico's electricity industry was considered at the end of the previous public administration (from 1994-2000). The most important argument was that the federal government did not have the financial resources to maintain or increase the level of operations of the semi-official electric sector, and that reforms to the 1992 law did not give the expected results with respect to private sector participation.

Unfortunately, the proposal was unsuccessful because of the general opposition within political parties other than the Partido Revolucionario Institucional (PRI), in control of government at the time. The reasons, although obvious, are worth mentioning. Banks, highways and other state company privatizations were disastrous requiring massive public finance commitments to avoid bankruptcies. In addition, the proposed electricity restructuring plan was adopted from Argentina. The extensive dislocation of workers experienced in that country triggered strong opposition from Mexico's electric industry unions.

After the 2000 national elections and resulting change of government and political control, it was expected that there would be new proposals to restructure the electric industry. Instead, the original proposal developed in 1999 was slightly revised to include an emphasis on the possibility of establishing a bulk electricity market, a feature already contemplated in the original version. Political weakness of the present federal government may be a serious obstacle for its initiative to restructure the electric sector, especially if the opposition of "official trade unionism" is considered.

Historical Evolution of Electricity Consumption

In most "emerging market countries", electricity that is produced is electricity that is consumed. Prices are generally administrated and set more like political objectives than market signals. In the case of the CFE, an excessively high

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[1] See footnotes at end of text.

price can be justified given its status as a public monopoly, but a price excessively low can also be justified considering its dependency on the federal budget. The CFE's operating deficits become, eventually, current and capital transfers from the federal government.

Electricity Consumption by Region and by Consumer Category

The aggregate analysis of electricity consumption facilitates detection of the historical path of this variable, but hides the differential evolution of diverse sectors of the economy. Fortunately, there is information about electricity sales to six categories of final consumers: residential, commercial, services, agricultural and medium and large industry (Table 1). The information in Table 1 shows that electricity consumption in the industrial sector constitutes more than 50 percent of the total market, and that it has increased in recent years.

Levels of regional development in Mexico and economic activity in each region also define consumption paths and differential evolution of demand. Different regionalization criteria have been developed in accordance with different

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Table 1
Electricity Consumption by Region and by Consumer Category (GWh)

Border region

Year	1988	%	1990	%	1995	%	1999	%
Category								
Residential	5,444.4	22.3	6,440.9	23.2	8,615.0	23.9	10,785.3	22.6
Commercial	1,734.2	7.1	1,952.1	7.0	2,175.9	6.0	2,633.1	5.5
Services	756.5	3.1	784.1	2.8	765.1	2.1	794.6	1.7
Agricultural	2,584.2	10.6	2,693.0	9.7	2,687.8	7.5	3,081.2	6.5
Industry	13,910.2	56.9	15,935.1	57.3	21,743.1	60.5	30,438.4	63.6
Totals	**24,429.5**	**100.0**	**27,805.2**	**100.0**	**35,986.9**	**100.0**	**47,732.6**	**100.0**

Central Region

Year	1988	%	1990	%	1995	%	1999	%
Category								
Residential	4,427.1	18.7	5,305.9	20.5	7,469.6	24.6	7,761.3	20.9
Commercial	3,076.4	13.0	3,374.7	13.1	3,813.9	12.5	3,994.6	10.8
Services	1,774.4	7.5	1,698.9	6.6	2,009.3	6.6	2,108.0	5.7
Agricultural	328.3	1.4	343.8	1.3	360.5	1.2	424.8	1.1
Industry	14,054.5	59.4	15,105.5	58.5	16,756.4	55.1	22,890.7	61.5
Totals	**23,660.7**	**100.0**	**25,828.8**	**100.0**	**30,409.7**	**100.0**	**37,179.4**	**100.0**

Rest of the States Region

Year	1988	%	1990	%	1995	%	1999	%
Category								
Residential	6,953.4	20.6	8,642.3	22.5	12,377.0	26.4	14,823.9	24.7
Commercial	2,506.3	7.4	2,957.9	7.7	3,659.5	7.8	4,335.9	7.2
Services	1,910.4	5.7	2,045.9	5.3	2,509.9	5.3	2,529.1	4.2
Agricultural	3,496.3	10.3	3,670.6	9.5	3,641.5	7.8	4,490.5	7.5
Industry	18,928.1	56.0	21,172.4	55.0	24,780.5	52.7	33,905.0	56.4
Totals	**33,794.5**	**100.0**	**38,489.1**	**100.0**	**46,968.4**	**100.0**	**60,084.4**	**100.0**

Totals

Year	1988	%	1990	%	1995	%	1999	%
Category								
Residential	16824.9	20.5	20389.1	22.1	28461.6	25.1	33370.5	23.0
Commercial	7316.9	8.9	8284.7	9.0	9649.3	8.5	10963.6	7.6
Services	4441.3	5.4	4528.9	4.9	5284.3	4.7	5431.7	3.7
Agricultural	6408.8	7.8	6707.4	7.3	6689.8	5.9	7996.5	5.5
Industry	46892.8	57.3	52213.0	56.7	63280.0	55.8	87234.1	60.2
Totals	**81884.7**	**100.0**	**92123.1**	**100.0**	**113365.0**	**100.0**	**144996.4**	**100.0**

Source: Gerencia Comercial, CFE.

Mexican Electricity Market *(continued from page 7)*

study objectives. For example, the CFE has its own regional breakdowns while Secretaría de Energía or SE, Mexico's energy ministry, provides data on electricity consumption for nine regions.[3] In our paper, we consider that the dynamic northern tier economy, promoted mainly by the maquiladora industry, has established an electricity consumption pattern that has not been studied. To compare electric power patterns for the whole country, we define only three regions:

- The Border Region comprised by the states of Tamaulipas, Nuevo Leon, Coahuila, Chihuahua, Sonora and Baja California;
- The Center Region comprised by the states of Puebla, Morelos, Hidalgo, Estado de México and the Federal District served by (partial or totally) the LFC; and
- The remaining states.

The rationale for our regional structure is based on the following criteria:

- In the northern border region, demand for electricity can be satisfied by a company located in Mexico and/or by

Table 2

National and Regional Average Prices by Consumer Category (cents per KWh)

National and Regional

Year	1988	Difference	1990	Difference	1995	Difference	1999	Difference
Region								
Border	7.94	0.985	13.22	1.005	25.01	0.978	49.76	0.952
Central	8.85	1.098	14.27	1.084	27.83	1.089	57.02	1.091
Rest	7.60	0.943	12.37	0.940	25.14	0.984	51.33	0.982
National	8.06		13.16		25.66		52.27	

Border Region

Year	1988	Difference	1990	Difference	1995	Difference	1999	Difference
Category								
Residential	7.78	0.965	13.58	1.032	26.52	1.038	52.75	1.009
Commercial	15.36	1.906	26.88	2.043	63.74	2.494	118.58	2.269
Services	8.69	1.078	19.41	1.475	43.44	1.700	97.46	1.865
Agricultural	2.30	0.285	3.42	0.260	13.80	0.540	26.10	0.500
Medium Size	9.16	1.136	14.84	1.128	23.43	0.917	50.85	0.973
L. Industry	6.80	0.844	10.26	0.780	15.35	0.601	35.40	0.677

Central Region

Year	1988	Difference	1990	Difference	1995	Difference	1999	Difference
Category								
Residential	6.84	0.849	9.82	0.746	24.57	0.961	48.47	0.927
Commercial	14.99	1.860	25.34	1.926	58.08	2.272	115.21	2.204
Services	8.85	1.098	19.75	1.501	40.73	1.594	89.94	1.721
Agricultural	2.12	0.263	3.15	0.239	13.09	0.512	25.09	0.480
Medium Size	9.00	1.117	14.20	1.079	23.60	0.923	51.97	0.994
L. Industry	6.92	0.859	10.50	0.798	16.11	0.630	37.36	0.715

Rest of the States Region

Year	1988	Difference	1990	Difference	1995	Difference	1999	Difference
Category								
Residential	6.81	0.845	10.56	0.802	24.73	0.968	45.96	0.879
Commercial	14.74	1.829	26.06	1.980	60.33	2.360	121.02	2.315
Services	8.58	1.065	18.77	1.426	41.62	1.628	94.50	1.808
Agricultural	2.14	0.267	2.98	0.226	13.26	0.519	25.54	0.489
Medium Size	9.30	1.154	14.88	1.131	25.65	1.004	54.27	1.038
L. Industry	9.48	1.176	10.05	0.764	15.12	0.592	34.45	0.659

Source : CFE,Gerencia Comercial

companies located in the United Sates.

- The region served by LFC has a market that is important to analyze separately given that the company is managed with autonomous administrative criteria (quasi public).
- The region comprised by the rest of the states is currently served by the CFE and in the future could be served by private companies, all located within Mexico (i.e., no possibilities for cross-border trade).

The importance of each region to total consumption of electricity depends on historical factors and on more recent events such as the NAFTA treaty. Historical factors, such as regional concentration of population as a result of urbanization beginning in the 50´s and concentration of industrial activity, explain regional consumption of electricity. On the other hand, the NAFTA treaty partially altered the impact of some factors on industrial location, and because of that, produced a different pattern in electricity consumption that remains today. Table 1 shows the quantitative impact of these factors. As expected, the border region has increased its share of the Mexican electric market, increasing from 30% to 33%. This may seem like a very small change but it is important to consider that the consumption base is very high. Table 1 also identifies categories of consumers that are the source of changing market shares. Industrial and residential categories account for more than 80 percent of electricity consumption in each region with industrial consumption alone comprising almost the 60 percent, although industrial consumption in the border region takes up almost 64 percent of total regional use. Another relevant fact is that only in the border region does industrial consumption increase its share with respect to total regional demand, while in the central states and the rest of the country, the share of industrial use has remained constant. Finally, Table 1 also shows that residential consumption accounts for 20 percent or more of total consumption in our three regions. However, only in the border region has residential use remained constant during the period under consideration. In our other two regions residential share has increased. This is important, given that considerable emphasis has been placed on residential consumption as being subsidized by industry.

According to SE's most recent data (SE, 2000), it is expected that national electricity consumption will increase at a 5.9 percent average annual rate of growth from 2000 to 2009.

Evolution of Electricity Prices in Mexico

In countries like Mexico, with administered prices, it is known that the market is cleared by quantities and not by price. That is, the price is set and if the quantity demanded is greater than the quantity supplied, then some rationing mechanism is designed. If at that price the quantity demanded is lower than the quantity supplied, then production is reduced. If the market works this way for a long time, price is an adequate reference to evaluate the profitability of investment projects in the market, but it provides little information about the market's efficiency. It is necessary to mention this because the information about prices shown here reflects additional criteria, other than market interactions, given that price administration for electric power is part of the general economic policy of Mexico.

As shown in Table 2 (national and regional data), the price structure among regions has not changed much from 1988 to 1999. This indicates that with regard to price changes the federal administration has tried to keep the same structure, one in which the central region has an average price slightly higher than the other two regions. This statement is based on data in the columns labeled "differences," where difference is calculated as the ratio of the corresponding average regional price to the average national price for the same year. In these columns a number greater than one indicates an average regional price higher than the average national price, and any number smaller than one indicates an average price lower than the average national price.

Due to the fact that in the Mexican market there are substantial subsidies, mainly to the residential consumption of electricity (SE, 1999, pp. 22), it seems convenient to describe prices across our specified regions and across final consumer categories in order to deal with the issue of price subsidies.

The information in Table 2 (border, central and rest of the states regions) shows that price structure is very similar in each region since in all of them average prices for the commercial and services categories are highest. In contrast, prices in the large industry and agricultural categories are the lowest in each region. If prices are compared among the regions, we observe that, in 1999, the border region had the highest prices in the residential, commercial, services and agricultural categories. In the case of large industry, the differences are small, but it is important to take into account that this category is one of the largest in volume of electricity consumed, and that in all three regions its price is below the national average.

Comparison with the national average price may seem arbitrary, given that this comparison should be done with respect to the average total cost by region. This indicates that it would be necessary to have disintegrated data for generation, transmission and distribution costs by region. The availability of this information could allow us to understand subsidies by consumer category and by region. The information analyzed clearly reflects a price policy that hardly obeys a real structure of costs. Surely there are very different criteria to the costs that have been integrated in pricing policy, and they would have to be defined explicitly in any reorganization program for the industry. There is not enough published information about costs. In one of the few published papers, Bastarrachea (1994) shows data on the ratio of price to cost from 1955 to 1993, and on subsidies from 1975 to 1993. From this data the following observations were made.

- From 1970 to 1972, the ratio of price to cost was greater than one.
- From 1973 to 1993 (the last year of data included in the publication), the ratio of price to cost was less than one, reaching a minimum of 0.57 in 1983.
- Subsidies appear regularly from 1978 on and the percentage of sales that they represent has decreased considerably. For example, in 1982 subsidies were 72 percent of sales while for 1993 this percentage decreased to 16.0 percent.

The 1999 Annual Report of the CFE (CFE, 2000) reported the same data for 1998 and 1999. It shows that the

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ratio of price to cost has been lowered (0.75 and 0.73, respectively) and the ratio of subsidies to sales has been increased (32.5 percent and 38.8 percent, respectively). *These values denote a non-acceptable financial practice with respect to efficiency criteria in a market economy, a practice that should also be reviewed in any reorganization program for the industry.*

The Supply of Electricity and its Components

Generation of Electricity

Since the electric industry was nationalized in Mexico, generation of electricity has been the responsibility of the government through the so-called "semi-official" sector (which includes the CFE, LFC and Pemex). Recently, there has been some participation by the private sector through cogeneration projects, self-use production and independent production. The number of private sector projects has increased, but they represent a small percentage of total generation capacity.

Table 3
Installed Capacity of the Semi-official Sector.

Year	Capacity (MW)	Variation (MW)	Gross Generation (GWh)	Plant Factor * %
1988	23,554	———	101,905	49.4
1989	24,439	885	110,101	51.4
1990	25,293	854	114,325	51.6
1991	26,797	1,504	118,412	50.4
1992	27,068	271	121,697	51.3
1993	29,204	2,136	126,566	49.5
1994	31,649	2,445	137,522	49.6
1995	33,037	1,388	142,344	49.2
1996	34,791	1,754	151,889	49.8
1997	34,815	24	161,385	52.9
1998	35,255	440	170,982	55.4
1999	35,675	420	181,988	58.2

Source: CFE and the Energy Ministry.
*Plant Factor = [(Gross generation)/(Installed capacity)x8.760]x100

As shown in Table 3, the installed capacity of electricity generation of the semi-official sector has grown in a continuous manner from 1988 to 1999, but annual variations have been very acute. Additionally, during the last three years there has been a reduction in installed capacity additions, which explains the attitude of energy sector officials regarding the urgency to invest in new increments.

Gross electricity generation, which has a high correlation with installed capacity, also has increased during the period analyzed but with variations that have little relationship to variations in installed capacity. It is important to mention that the upward tendency in "plant factor" in the last years is a reasonable indicator of the pressure that demand has exerted over supply. This has forced the system to a higher efficiency, integrating reserves with normal operations.

Plant factor captures technological, climatic and operational conditions. It is almost impossible to get a 100 percent efficiency factor due to the fact that electricity demand has daily, weekly and seasonal variations. Some generators only start up during peak demand, and for the same reason their capacity will remain idle much of the time. During drought periods, hydroelectric plants will not work at their maximum capacity, a fact that tends to decrease the plant factor estimate.

This issue leads to analysis of the evolution of generation capacity with respect to categories of plants that generate electricity. A quick review shows, as expected, that the installed capacity of electricity generation has evolved in such a manner that hydroelectric plants have become a smaller portion of total installed capacity. Table 4 shows the share of each type of generator within the installed capacity for Mexico.

Table 4
Participation of Each Type of Generator Within Installed Capacity (Semi-official Sector).

Year	1988		1999	
Category	Capacity (MW)	Participation (%)	Capacity (MW)	Participation (%)
Thermoelectric	13,955	59.2	21,351.1	59.8
Hydroelectric	7,749	32.9	9,662.8	27.1
Coal-Fired	1,200	5.1	2,600.0	7.3
Nuclear	0	0	1,309.1	3.7
Geothermal	650	2.8	749.9	2.1
Aeolian	0	0	2.2	N.S.
Total	23,554		35,675.1	

Source: SE.

Besides the semi-official sector, the private sector also participates in the generation of electricity even though the proportion of privately generated power declined during the period 1988-1999. For example, in 1988 the private sector made up 7.2 percent of total electricity generation, while for 1999 its share reached only 5.2 percent. It is interesting to note this fact given that private generators have increased in absolute numbers, but with a lower total capacity than observed in the semi-official sector. (The relatively recent opportunities for private generation coupled with the restriction regarding sale of surplus power to CFE and pricing policies in Mexico explains the small contribution.) Additionally, these figures show that reforms in the electric sector have not had the desired impact, and that they must be deepened if the private sector is to participate more actively in electricity generation.

When comparing data on electricity generation within the private sector with installed capacity for 1997, the plant factor was almost 35 percent (INEGI, 1999), a percentage lower than that of the semi-official sector.

Regarding fuel consumption in power plants, in 1999 hydrocarbons accounted for 63 percent of energy transformed by the electric industry. Eighteen percent corresponded to hydroelectricity, 10 percent to coal, 6 percent to nuclear and 3 percent to geothermal and wind (SE, 2000).

Information on regional installed capacity may seem irrelevant due to the institutional arrangement of Mexico's electricity market. In this arrangement, regions and their distinctive characteristics are not the basis for defining regional markets but rather the geographic obligations of CFE, which must provide electricity in an efficient manner. Without market competition, the CFE's efficiency is only a function of its capacity to serve the national market given that

traditionally its costs are not compared to international costs. The obvious conjecture is that there is a regionalization based on production, transmission and distribution costs of electricity which should be reflected in the prices that the CFE charges to consumers.

With rational, natural regional markets, the location of electricity generation plants would depend on the existence of natural resources (water in the case of the hydroelectric plants), the availability of fossil fuels (as in the case of thermoelectric plants) and price levels and market conditions (demand). Proximity to big consumer centers could be another important variable, but that advantage is partially offset by environmental and congestion costs that tend to be reflected in high location costs.

The available information about electric generation capacity using the regional criteria established in this paper is shown in Table 5.

Table 5
Electric Generation Capacity (MW)

Region	1993	1998	2000*
Border	8,097	9,395	11,415
Central	4,143	4,111	4,111
Rest of States	16,964	21,750	22,287

Sources: INEGI and CRE.
* Estimate on base of authorized projects.

Installed capacity in the Border Region is not interconnected given topographical constraints. In the case of the state of Baja California Norte, its connection is mainly with the state of California and the U.S. The states of Sonora and Chihuahua have small connections with the main Mexican transmission system and also with U.S. border states. Finally, the states of Coahuila, Nuevo Leon and Tamaulipas have large connections with the Mexican transmission grid and with the state of Texas. The central and rest of the states regions operate, as expected, only within the Mexican system. Thus, four regional markets can be distinguished: Baja California Norte, Sonora, Chihuahua and the so called northern zone comprised by the states of Coahuila, Nuevo León and Tamaulipas.

According to most recent data from SE (2000), about 26,281 MW of power capacity should be installed in Mexico between 2000 and 2009. Of this, 12,054 MW are already under construction or planned through BLT or IPP projects. More than 14,000 MW of planned new capacity remains unfinanced and represents an excellent opportunity for private investment.

Transmission and Distribution Infrastructure

The transmission and distribution infrastructure has to be planned and executed jointly with the generation of electricity. The National Electric System (NES) consists of transmission and distribution lines, distribution substations and distribution transformers that are used to move the electricity from the generation plants to final consumers adjusting voltage and current according to their needs.

With respect to transmission lines, SE (2000) mentions that high-tension lines of 230 to 400 KV are used to transmit electricity long distances. These lines feed sub transmission nets, which have a narrower scope and range from 69 to 161 KV. In a similar manner, sub transmission nets feed medium tension lines that range from 2.4 to 60 KV and are used for small geographical areas. Finally, low-tension lines that range from 220 to 240 volts are used to transmit electricity to low consumption consumers. Information about length of the lines of each type of tension varies according to the information source, and because of that we decided to use data provided by SE because of larger coverage over time (Table 6).

Table 6
Length of the Transmission, Sub Transmission and Distribution Lines (Kms).

Year	Transmission	Sub Transmission	Distribution	Total
1980	18,021.3	26,000.7	160,693.9	204,715.9
1985	22,035.0	34,219.0	344,208.0	400,462.0
1990	27,433.0	38,616.0	426,838.0	489,887.0
1995	30,791.0	39,469.5	494,399.1	564,599.6
2000	35,921.3	43,395.7	567,115.5	646,423.5
AARG (%)	3.5	2.6	6.5	5.9

AARG = Average annual rate of growth
Source: The Energy Ministry and own calculations.

Mexico's grid is complemented with transmission and distribution substations, and distribution transformers. According to CFE data, in 1998 it had the following infrastructure:

- 300 transmission substations with 96,679 MVA belonging to the CFE and 38 private substations;
- 1,239 distribution substations with 28,241 MVA belonging to the CFE and 389 private substations; and
- 678,575 distribution transformers with 22,870 MVA belonging to the CFE and 169,481 private transformers.

This complex system has as a main objective to provide quality service to each one of the consumer categories at minimum operation cost. The CFE's experience in operating the National Electric System is not in doubt, and it is known to have utilized simulation and optimization models for many years. However, information regarding system losses exists, but does not have any explicit explanation in official documents. *It is possible to consider how much the country could save if system losses could be reduced by a certain percentage.* According to the CFE, system losses are calculated in the following way.

Net generation = gross generation – self-use
Available energy = net generation + imports + purchases
Losses = available energy – sales

Available energy is transmitted to final consumers using the transmission and distribution (T&D) system, and during this process some of the system losses occur. These losses are attributed, in part, to the lack of adequate T&D capacity. System losses also occur in the distribution of energy to small consumers, since it is known that many of them have illegal connections to the distribution system (residential and small commercial and manufacturing companies). In a World Bank paper on the Russian electricity system (1999), there is a clear distinction between transmission and the distribution losses. In the latter case it was estimated that non-technical losses

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comprised a little more than two thirds of all distribution losses. In the case of the Mexican electric system, the losses of the system are reported in aggregate, without any distinction between technical and the non-technical losses. This differentiation would be very useful to detect the areas for improvement. An estimation of system losses is shown in the Table 7.

Table 7
Electricity Losses (TWh)

Years	1985	1990	1995	1998
Concept				
Gross generation	85.3	114.3	142.3	171.0
Self-uses	2.9	5.7	6.3	8.5
Net generation	82.4	108.6	136.0	162.5
Purchases	0.1	0.6	1.4	2.5
Available energy	82.5	109.2	137.4	165.0
Total sales	71.1	94.3	115.6	139.7
System losses	11.4	14.9	21.8	25.9
Losses (%)*	13.8	13.6	15.9	15.7

Source: CFE and INEGI.
* Losses as a percentage of available energy.

Conclusions

We conclude with the following observations drawn from our analysis.

- Based on information shown in this paper, the Mexican electric industry has a long way to go towards efficiency, and this is one of the first problems that must be solved. One the one hand, the plant factor data indicates the possibility of increasing the efficiency of the generation system. One way to do this is improved maintenance for power plants and establishing demand side management (DSM) programs that can modify the pattern of demand over time. DSM programs can improve plant factor by means of reducing daily and seasonal demand fluctuations. This sort of program is already being used in the Mexican electricity market, such as establishment of summer daylight savings time and Mexican official norms for energy efficiency. DSM programs that encourage reduction of daily demand fluctuations could be used more extensively. Customer participation remains extremely important for success. However, if losses in the transmission and distribution system could be reduced, it is possible to infer that efficiency of the Mexican electric system could be augmented in a considerable manner without increasing the electricity generation capacity. Finally, though, no strategy is superior to the use of price information to ration demand. Removal of price subsidies, institution of real time pricing and other mechanisms would go a long way toward improving electric power market efficiency and ensuring that capacity additions are sensibly undertaken relative to demand and supply conditions. This is likely to be a long and contentious process.[4]
- As mentioned by Hartley (1998), electricity asset privatization with the sole objective of obtaining financial resources, whether to pay off debt or to finance government expenditures, is an inadequate decision. It is important to think seriously about the development of an electricity market that has been dominated by the operation of a state monopoly. Hartley recommends increasing the efficiency of the industry through price setting, eliminating subsidies to social groups (for example, electric power industry workers do not pay for their energy), rationalizing labor and establishing competitive regional companies. This last issue is possible given that the administrative regions established by the CFE could be the basis for the creation of regional companies, a strategy that has been discussed off and on over the years (Foss, et al., 1997). If operating efficiency of regional companies is increased, CFE's market value will increase and eventual privatization will generate more resources for Mexico than what could be obtained at the present time.

Acknowledgements

This research was supported in part by corporate sponsors of the Energy Institute, Bauer College of Business, University of Houston and ITESM.

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Footnotes

[1] *A Proposal for the Structural Change of the Electric Industry in Mexico* Secretaría de Energía (SE), 1999.

[2] *Prospective of the Electric Sector 2000-2009*, SE, 2000.

[3] *Prospective of the Electric Sector 2000-2009.*

[4] It has been mentioned several times in our paper that CFE financial losses become public debt. The costs associated with price subsidies and system losses have been such that CFE's deficit was estimated to be as much as 50 percent of Mexico's total energy sector (Foss, et al., 1998). This means that income elsewhere in the sector, for example from sales generated by crude oil exports by Pemex, is effectively reduced leaving little for reinvestment and thus creating the constraints on infrastructure improvements and expansion that we see today.

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